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## *Variety and Programed Instruction*

or

## *What Can't Be Programed?*

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The term "programed instruction" refers, in my mind, to a *process*—not a product. The first step in that process consists of an explication, or detailed account, of the behavioral changes that the programmer is attempting to produce, along with the develop-

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ment of valid measuring instruments to test whether the program reaches its objectives. Examples of desired behavioral changes might include: higher scores on examinations, increased skill in a manual task, or more competent performance in designing a research study or analyzing a painting, as indicated by judges' ratings on some checklist. When the objectives have been spelled out, the programmer engages in behavioral analysis, i.e., he determines the small components (abilities and skills) which make up the major changes he is attempting to engineer.

It is important to note that the programmer is engaged in the specification and the analysis of *behavior*—not content. The sophisticated programmer does not program a body of knowledge. He is not bound by the classical sequencing and information coverage which make up the content of the field. Rather, he is engaged in the study of how to produce certain changes. This distinction between content orientation and behavior orientation—between teaching something and teaching someone—is crucial to an understanding of how the programmer works, what can be expected of programs, and of the question: "What can be programmed?" Revised in the light of this discussion, the question might read: "What behaviors seem amenable to training that uses materials developed from the programming process?"

#### CONTENT CLASSIFICATION

Since we traditionally classify educational materials, including programs, on the basis of content, one cannot directly answer the last-stated question but must look at titles of available programs (2, 3, 4). Programs presently can be obtained in such diverse content areas as psychology, preschool training, logic, social studies, music, arithmetic and mathematics at all levels, business education, languages, physics, and nursing.

There are programs for professional education (e.g., biochemistry for medical students); specific skills (e.g., how to measure board feet, how to remember faces and names, how to use a micrometer); continuing education (e.g., programs on specific drugs, designed for an audience of doctors); etc. A reminder: We are not sure what behaviors are being developed in these programs; nor do we know—even after inspecting most of them—whether they produce the indicated behavioral changes. This we can discover only by trying them out.

Various workshops at the Center for Research on Learning and Teaching (CRLT) have started their participants on the road

to producing programs in such fields as art (appreciation of the visual arts), psychology (personnel selection), music (discrimination and notation of a series of notes), English (the analysis of short stories), and religion (the two-source theory about the synoptic problem). These workshops support the observation previously made on the basis of bibliographies of available programs, namely, that a wide range of materials are being programmed. Locally developed programs at The University of Michigan (in physiology, Latin, counseling) add further support.

If we were, then, to answer the question posed early in this paper on the basis of inspection of titles and content of programs, we would say that there seems to be no content for which a program is not already available or for which a program is not now being developed. It should be noted, however, that there are only a small number of commercially available programs whose titles suggest terminal behaviors rather than "content." For example, there is a program designed to produce "effective listening" (1) and another designed to produce improved interpersonal relations (5). This is not the time to do more than to suggest that programed instruction may lead to a radical restructuring of curriculum on the basis of behavioral goals rather than content classification.

#### OBJECTIVITY AND CREATIVITY

It has become a cliché in programed instruction to answer the question "What can be programed?" with the statement "Anything that can be taught." By this the programmer means that if the behavior has been taught, such a specification is possible though it may not have been verbalized by either the teacher or the student. The change that has taken place in the student may appear somewhat mysterious since the teacher can specify neither the objective nor, often, the means of achieving that objective. It is true that unless behavioral goals are described, it is impossible to develop a program to produce them. But as a teacher, even if I do not plan to develop a program, it seems that since I am engaged in producing behavioral change in a student, I should demand of myself such specification. When the teacher does not do so, he is like an engineer constructing an object which he cannot describe ahead of time but can only recognize when it is completed. Before one is able to decide that particular behaviors *cannot* be programed, he must spend time discovering whether or not he can specify, in quantitative terms, what the behaviors are.

(One attempt at such a specification is, obviously, the writing and scoring of a final examination.)

On this point a more precise statement by the programmer might be, "That which can be specified can be programmed." And the amendment might be added, "Efficient and effective teaching, programmed or not, probably depends upon the specification of terminal behaviors."

In programmed instruction one is often challenged by a question which the speaker assumes to be a rhetorical question: "You certainly can't program creativity or imagination, can you?" Suppose we take this *not* as a rhetorical question. In the light of what has been said above, the programmer might answer as follows: "If you can specify for me, or with me, what behaviors you regard as creative and imaginative, we can together attempt to write a program which will produce those behaviors." The immediate response might be that it is impossible to specify them. Indeed, it is difficult to recognize the product, much less the behaviors which produced it. The programmer might pursue the argument along these lines: "There must be some behaviors in other people which you respond to as creative and imaginative; let's engage in an investigation of the conditions—that is, the behaviors—which lead you to say the words 'creative' and 'imaginative.'" Or he might say, "Show me some examples of creative and noncreative behaviors." This is not to say that the problem is completely clarified at this point. For example, it seems that we often respond with such words as "creative" and "imaginative" to new, unique responses though newness or uniqueness is not the sole criterion for using these words. (Indeed, if it were, we would be unjust in confining to institutions some of the people who exhibit the most unique and original behaviors.)

Additional dimensions of the concept "creative" can be slowly extracted, but probably the definition will never be as exact as that of, say, pronunciation of Parisian French. The programmer will be faced with a most interesting and challenging problem: the production of behaviors which can be specified only in general terms but cannot be predicted at a molecular level. The problem of arriving at reliability among judges for such terminal behaviors is difficult enough; providing for accurate self-evaluation of such responses by the student (the comparator function)

is even more challenging. Programers are concerned with and are studying such areas as creativity, as readers of the programing literature know.<sup>1</sup> But, as yet, they are only on the threshold of identifying the behavioral components which, when combined in certain ways and under certain circumstances, produce the behaviors we call creative or imaginative. The important point is not that creativity can be programed (or cannot be) but that the question cannot be answered either way until the behaviors called "creative" are specified.

A similar problem concerns stereotypy and variability. A common criticism of programed instruction is that it is limited to those cases in which the result of instruction is the production of the same responses for all students. (Of course, many times that is precisely what we want. One might, therefore, conclude that given this restriction, there is still a great deal within the traditional content areas in education which can be programed.) I think that restricting ourselves this way, however, may prevent much imaginative and exciting programing. Suppose we do want to produce variation in response in a class of students. How do we go about doing it at present? Usually, we do not *do* much at all! We depend upon the different backgrounds and interests of the students to produce the variability. At best, we try not to suppress it. But because we do not know the causes of variability or do not consciously try to produce it, we must not assume that it is either uncaused or caused by a set of procedures other than those which produce stereotypy. To teach each of two children to speak English, one would go through the same instructional operations as teaching one child English and one child French. In the first case we would produce stereotypy, and in the second, variability.

We can take an active role in the production of such behavior, much as I feel that we can stimulate creativity. And, as with the above discussion of creativity, I think we can produce programs which develop individual behaviors in different students. The problem seems to be to define the classes of allowable variants and how much and what kinds of variability are acceptable. Once we have done this, it is as conceivable for a program

<sup>1</sup> See, for example, *Programed Instruction*, Vol. IV, No. 4, January 1965; *Carnegie Quarterly*, Vol. XIII, No. 4, October 1965.

to produce the results as it is for a teacher. Of course, an obvious solution would be to produce as many different programs (and, therefore, students) as we desire variants. On a slightly more subtle level, computer-based programs aimed at making use of and producing variation in the student are now being developed in a number of universities.<sup>2</sup> The computer, indeed, may be a more patient and sensitive instructor for this kind of teaching than the human.

#### ROTE VERSUS CONCEPT

One of the most common responses made by teachers in discussions of programed instruction is, more or less, as follows: "I know of a great deal of material in my course that I would like to program—rote material—material that every student has to memorize. It seems silly that I should stand up and lecture on such things." The teacher has dichotomized material into *rote* and *conceptual*. I am not sure that I understand the definitions of these two terms. Sometimes "rote" seems to refer to something intrinsic in the materials (a vocabulary list, a telephone number, etc.); sometimes it seems to refer to the behaviors learned ("he repeated in a rote way what he had learned"), sometimes it seems to refer to the method of learning ("learning by rote"). And, occasionally, all three characteristics seem to be present. Similarly, the term "concept" or "conceptual" has numerous and quite different referents. "Concept" will be used here as defined by Keller and Schoenfeld (5, p. 155): "generalization within classes and discrimination between classes."

I suppose that traditionally "rote" refers to a situation in which responses are automatic or unmediated. Thus, we might say the student learned or replied by rote when we observe him instantly responding to the phrase "1492" with the statement "Columbus discovered America." It is not the purpose of programed instruction to teach such responses. Indeed, I should guess that they can be most economically taught in the traditional ways. Given a list of paired associates (pairs of words or phrases), the average student can commit them to memory.

The deeper, more important question really is: "Why would

<sup>2</sup> For examples of such activities, see: Stolurow, Lawrence M., and Davis, Daniel. "Teaching Machines and Computer-Based Systems." *Teaching Machines and Programed Learning, II: Data and Directions*. (Edited by Robert Glaser.) Washington, D.C. : National Education Association, 1965. pp. 162-212.

we ever want to teach such things?" With the advent of the printing press, the library, and, today, sophisticated information-retrieval systems, one muses at the amount of time we spend cramming such "facts" into the heads of every student. It is as if we were on the verge of losing, at any moment, all the tables, reference books, etc., that we have evolved over the centuries.

Far from being the instrument for teaching such often inane reflexes, the programed instruction process, being expensive, time consuming, and exhausting, makes us examine very carefully what we are determined to teach. By its very nature it makes us justify the tremendous effort we are about to engage in before we start. In this way it tends to focus the programmer on teaching crucial concepts rather than a myriad of facts. Though it is true that most available programs are little more than texts on which surgical removal of words has been done, we look forward to programing as an instrument of concept formation rather than one of information passage. A few programs have demonstrated that this is not only possible but that the program is often the most efficient way of developing the concepts at hand.

SUMMARY I have attempted first to define programed instruction primarily in terms of a process by which self-instructional materials are developed. Using that definition, I have tried to deal with the problem "What can be programed?" by citing several kinds of answers: in terms of traditional content categorizing, on the basis of specifiability of the outcomes desired, and in terms of the traditional rote-versus-concept dichotomy. This essay attempts to break away from stereotyped answers to the question posed at the outset and to produce new questions rather than present old answers.

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